Impact of Information-Handling Systems on Quality and Access to Health Care

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INFORMATION SYSTEMS are not unique to the field of health care. These systems are simply a consequence of balancing expenditure in any modern organization striving economically and competitively to reach certain goals. So, much as can be said about the proper use of information systems, on-line computers, and so forth in medical research, the need is to consider the information system with which the consumer, or the data on him, interacts.

I am particularly concerned with health care procedures that directly affect the individual consumer, such as his annual medical examination, if any, his purchase and administration of drugs, his entry into a patient data bank, his X-ray and medical record, his appendectomy, his bone implant, his interview with the physician, and his 6 hours in the waiting room.

I would like to consider the consumer in relation to a possible structure for the health care industry in 1975. No coherent structure such as this diagram will evolve without work, discussion, and planning. In fact, the shape of the structure depends not only on technological and medical questions but more largely on the population's scale of values. These values are often not expressed openly and must be inferred. Whether this particular structure is optimum or acceptable is too difficult to settle here, and the structure is used simply as an illustration.

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Purpose of Information Systems

Information systems are justified because they can do existing tasks more cheaply in dollars, people, or delay, which itself should be reflected in dollars. Even in saving time a decision is not always easy. For example, a system which provides results of a blood chemistry analysis in minutes rather than in half a day may save patient-days in the hospital. This saving which accrues to the hospital, the third party which pays the bill, or the consumer is not reflected on the balance sheet of the analytical laboratory, yet it must be considered in deciding to automate or modify. At present, no mechanism seems to exist to enable such decisions to be made easily, and while information systems may help medical economists understand better these interactions, the solution would seem to lie in part in proper incentives.

A second function and justification for information systems is to do new jobs, particularly those involving random access to large masses of information as well as requiring some computing capacity. People are performers and consumers in this system and a reasonable response time is required from the system, perhaps even a variable response time depending on the urgency of the particular case or on the value

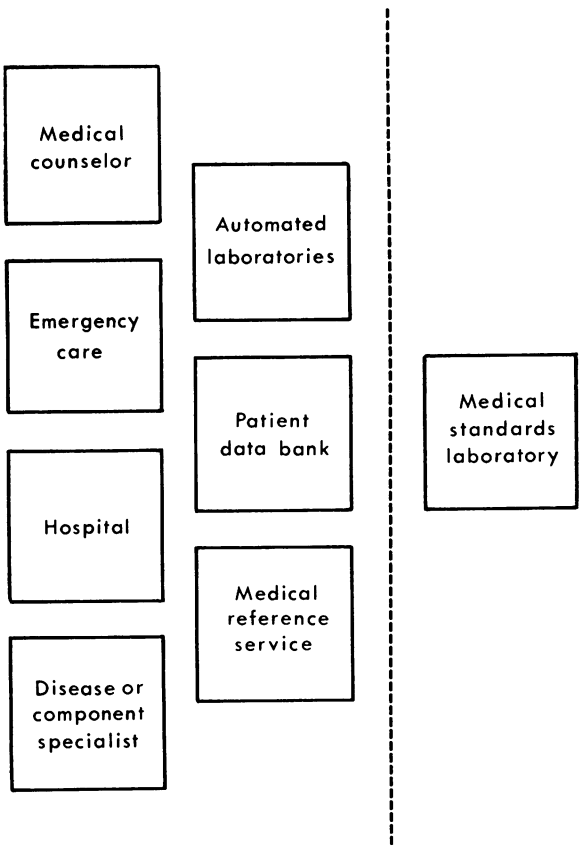
which the individual person places upon his time.

The possibilities of modern information systems do affect the structure of the industry that provides health care. The interactions are many, as are the opportunities in the present system for cutting cost and improving efficiency.

A Possible Future Structure

The diagram shows a possible system for the provision of health care. To the left of the dotted line are elements with which the consumer will come into contact and which will handle the information peculiar to him. This diagram excludes an important part of the total health care system—the research, development, and education components necessary for the continued efficient and effective operation of any structure. These are also elements which determine how the structure evolves with time.

Structure of a system for the provision of health care



This structure may clarify some of the interfaces. Consider some of the information flows in the diagram. The automated laboratory receives a sample of blood and provides a prompt and accurate report on its composition—chemical, enzymatic, cytological, and so forth. The automated laboratory might even accept the individual person (as a large specimen) for multiphasic periodic examinations, although alternatively clinics might fulfill this function. In the diagram the laboratory report goes to the patient data bank and is available, on authorization by the patient, to the physician, hospital, or medical counselor.

Patient Data Bank

The data bank will eventually contain data both current and historical on each patient. The choices of physical location and structure of the data bank are determined in part by the economies of scale in the provision of extensive files, computers, and operating personnel. Militating against extreme centralization, however, are the costs of communication over the consequently long distances over which information must be communicated from the data sources to the bank and from it to the physician, hospital, or counselor.

In large part, the data bank will probably replace the medical record, portions of which are now scattered among the offices of the individual physician, the hospital, and the specialist. The data bank will necessarily be centralized. It is at least a possibility that each person will carry with him all his personal medical information in the form of a microphotographic record which could be updated as needed. However, the necessity to have access to the data in the absence of the body of the consumer suggests that the more conventional file will be used.

Conceptually, therefore, the data bank contains only information on the individual patient, such as the results of laboratory tests, information entered during hospital visits, records of sickness and immunizations, medical questionnaire filled out upon entering the system, and eventually X-rays and the narrative record of physicians who may interact with the patient. It is perfectly feasible to have access via telephone lines and simple terminal equipment to

files located anywhere in the country and, indeed, at a reasonable price, anywhere in the world.

The data bank, created to provide better recordkeeping and service to the consumer, would be also an invaluable resource for medical research. Statistics of disease, variability of certain measures, and indices to health, for example, could be available to qualified researchers under proper safeguards from the patient data bank. I believe that these safeguards are possible and easier to implement with such a central file than with the present manual and scattered filing systems. I also believe that the safeguards must be subject of public debate and that an informed political process—discussion, legislation, and even constitutional amendment—must set the ground rules under which information is made available other than in contributing to the care of the individual patient.

Finally, the patient data bank and the automated laboratory can yield much more sensitive indications of the state of health or of incipient changes in a patient which may be valuable to identify and treat disease or to preserve health. Together, the data bank and the laboratory would make feasible use of the self-norm rather than the population norm to detect abnormalties in the individual. Inexpensive, routine automated testing and the existence of a patient data bank may be able to provide baseline information on each individual for comparison with subsequent screening or for diagnosis of disease.

The criterion for the use of a self-norm must be that the variability of the results of a particular test over the general population be greater than the variability of the results of a test repeated on a single person. For example, it is of some relevance to a neurologist to know that his patient with an IQ of 100 on May 23 had an IQ of 120 a year earlier, although 100 is an essentially "normal" IQ. Similarly, genetic abnormalities of the enzyme systems of the body or of the structure of the heart broaden the range of normality in the population and set in some instances unnecessarily wide limits on the excursions acceptable in an individual before an irregularity is detected.

I wish I could give the number of characters of storage required in the data bank and precisely how graphic, narrative, and pictorial information will be handled. There are no firm answers, only ranges, and an informed choice must be made with the aid of research and development, not only by those concerned with producing and selling patient data banks but also by those interested in the existence and efficient use of a health care system.

Medical Reference Service

The medical reference service can take many forms. Such a service requires communications and information storage, but it might offer many facilities. At least, the reference service should provide up-to-date material readily accessible to the physician through a convenient communications terminal. Its minimum capability might include the United States Pharmacopeia, synonyms and prices of various drugs, names and hours of specialists in various diseases, and a specialized medical reference library. Other features which might well be offered and which require computation as well as information-handling are to accept electrocardiographic signals over the telephone line (as is done today experimentally), to compute and classify, and to deliver via the terminal a typical cycle of the electrocardiogram and a notation and tentative significance of any abnormalities. Beyond that, if it did not prescribe treatment, the medical reference system might offer machine-aided diagnosis to help the physician or medical counselor set priorities.

In comparison with the patient data bank, realization of the medical reference service presents certain problems. A data bank can start with individual physicians, group practices, hospitals, and clinics filling it gradually with records of individual patients as other patients come into contact with the system. The medical reference system, in contrast, to be useful even to one physician, must incorporate a great quantity of reference material, have the ability to process electrocardiograms mechanically, and be ready to support the physician in many situations. Thus, the jump to a medical reference service is a much larger one than the step to a patient data bank. Fortunately, the com-

munications and terminals required are similar for the two, so that the further investment in the medical reference service is almost entirely in information content and not in hardware.

Medical Counselor

The diagram shows some other components which seem to be required for an efficient system that will use the information-handling capability which will exist in the next decade. Medical counselors, presumably practicing in many geographic areas but with background and training so far unspecified, could be the consumer's normal point of contact with the system for health care. At this point, part of the medical record could be taken, questionnaires filled out with human or machine help, samples taken for the automated testing laboratory, and appointments made. The medical counselor might also be available by telephone and could serve as the individual consumer's guide to the health care system.

The consumer moves through the system for diagnosis and treatment, and information pertaining to him must both precede and follow him. The body of information is augmented at each stage as additional results are obtained and as treatment is effected. The existing system of medical records is inadequate both as to availability of the record itself and in the quality of the information, even in good hospitals. There is really no existing solution to the transfer of information across the interface of private physician and hospital or the interface of two hospitals.

Medical Standards Laboratory

A system which is not monitored and corrected will accumulate disabilities and mutations and will decay. The medical standards laboratory serves the monitoring function for this system. For instance, it sends blind samples, to the extent perhaps of 10 percent of the workload, to the automated laboratories, checking the response time and the accuracy of the results.

System Design

In the design of a large system, the interfaces and the couplings are crucial. After the system is defined to the block-diagram stage, it seems easy to have competent work done in each block, but interfaces and information transfer points must be defined earlier, and this process leads to what may seem to be unavoidable inefficiency and sub-optimization in the system. This defect, in my opinion, can be remedied only by building systems for growth and with the aim of replacing them in 5 or 10 years. Because the structure depends so much on the state of technology, I would hate to see a system defined for all time by the early, crude tools we now have, but it would be even worse to postpone the real benefits to be obtained now while awaiting the ultimate technology.

Problems in Improving the System

The patient data bank and the medical reference service contain information of different kinds and communicate with other elements of the system—the automated laboratory, the medical counselor, the hospital, the medical specialist, and private physicians—via communication lines and terminals. A hospital information system which provides integrated information service only within a hospital is of little use to the physician treating the same patient before admission or after discharge. I cite this fact to stress that the approximate definition of the information flow between the units of the structure is more important than improving information handling within any of the units. Although a hospital can, with sufficient initiative and money, invest in and benefit from a hospital information system, historically the hospital has not gone out into the neighborhood to serve the consumer directly via outposts staffed by medical counselors and to clients of a private physician via a terminal to the hospital information system.

Further, private industry finds it difficult to decide to produce a large system for which no customers exist. It is possible, however, to visualize such a system and to offer individual services to its different components while waiting for the demand for other services to grow; for instance, one might delay the implementation of the capability of information transfer via the system from private physician to hospital to testing laboratory.

Getting Started

What seems to be required is an experimental model in which one or two hospitals participate with some medical counselors, private physicians, and automated testing laboratories. The magnitude of investment in a patient data bank would not be large in such a model, but the system would be sufficiently large to include all the types of interfaces required in a system on a much larger scale. It is most important to regard such a system as an experiment and to use equipment which is reliable. This equipment is also expensive because it is early equipment. In creating such an experiment, there would have to be an investment of funds on which only a partial return was expected and an investment in people who observe the operation of the system. Also required would be extra monitoring capability to compare various trial configurations and the willingness to replace portions of the system with other concepts and techniques immediately as these become available.

In my opinion, it is urgent to conduct such experiments, since the continued provision of health care to the population, as well as its expansion in quality and extension in quantity to those who do not receive an adequate level of care, depends upon such innovations. Thus the experiment must be done in a developmental context, not in a purely academic or a research environment, although academic and research people will be closely associated with it.

I believe that our nation is often faced with the choice between very large investments in the current way of doing business and substantially smaller investments in more efficient and economical ways of providing a better service. The second possibility, however, which offers so much more beyond the first generation of investment, depends upon new organizational concepts and new experimental programs. In these programs physicians and hospitals and private industry can work together with suitable motivation and incentives, among them the excitement of participation in an effective program to help our people fulfill the promise of human life.

Current expenditures for experimentation and development in the delivery of health care are woefully inadequate, certainly by the standards of the large technological segment of industry which spends some 10 percent of its income on development. I do not propose to divert funds from biomedical research, but I do wish to see at least 5 percent of the $43 billion expended annually for health care spent to investigate and demonstrate ways in which health care can be less expensive and more widely and readily available.

Thus, I see information transfer in the health care system of the future playing these almost mystical roles.

1. It serves as a surrogate for the patient, with a single examination replacing several and one medical record-taking replacing eight. In addition, the medical record which accumulates in the patient data bank will be much more reliable than that in the mind of the patient and on pieces of paper in the offices of a dozen or more physicians scattered over the country. Thus the information system is an efficient way to obtain information on the patient and subsequently to keep it uncorrupted and readily available to authorized users.

2. The information transfer system gives the physician ready access to current, specialized knowledge and to routine but complex procedures of information processing. As a result the patient may receive improved and more economical care, even in such mundane matters as prescriptions better tailored to his symptoms and individual characteristics. In addition, the medical reference service can be a means of continuing education for the physician or other user.

3. The transfer of information may leave a trace in the system and may serve as a monitor of the system's performance to help improve the organization of the system itself.

4. Information about the health and illnesses of consumers will be available for extensive research, which should lead to more sophisticated evaluation of alternative modes of treatment, better epidemiology, and a greater sensitivity of the system to side effects of drugs or to the interactions between two or more drugs.

Beyond the bare bones of the system in the diagram, the possibilities are fascinating. The medical reference service can provide the physician with such diverse services as a medical newsletter tailored to his own interests or refresher courses in his specialty. The availability of the medical reference service might ease the

trend toward specialization, since specialized information would be rapidly available to the practicing physician who might then be free to specialize in his patients as an alternative to specializing in a branch of medicine.

Similarly, the use the consumer himself might make of the medical reference service is a matter for discussion and experiment. The medical counselor could use the service to arrange for the consumer appointments for appropriate tests or consultations. I also wonder if a medical reference service of this type existed, how much the education of physicians would be altered by the ready availability in their practices of information as well as judgment.

As computer-assisted instruction establishes a place for itself in higher education, it could be imaginatively applied to the education of physicians and other health care personnel. After all, we are educating health care personnel for a world in which they will use information systems. Should not they have contact, if not with the precise and as yet unspecified systems which they will use in the future, then with systems which, although different, will give them a feeling for the value and means of utilization of such systems? Their educational experiences should create a critical but receptive attitude toward later introduction of such innovations.

Finally, the availability of information about the health care system should allow the intelligent and sophisticated consumer to care better for himself and his family.

Conclusions

While decision as to the advisability of the particular system I have sketched requires a great deal of planning, research, and experiment, some elements—the patient data bank, medical questionnaire, and medical reference service—will, I believe, be part of the health care system of the future. We should invest now the intellect and capital required to understand and master these systems and their uses.

Possible arrangements of these new tools seem to be an appropriate and challenging form of graduate work for university departments of economics, sociology, and public health. I should like to see a competition among concepts in both planning and experimental stages before a system is chosen to be copied widely. However, I must express two cautions. We should recognize the difference between a system in the process of development and one which has been fully developed and is ready for replication and use. We should also be ready and eager to spend money and time to develop a system to compete at some future specified time with continued use of an older, more expensive, and less efficient system.

Questions for Managers and Administrators

These questions regarding the decision to install an information system were raised by Michael F. Parlamis of the George A. Fuller Company, Inc., New York City.

Is having more information desirable and necessary for your firm or agency?

Are you prepared to provide for ready access to data processing equipment through direct purchase, time sharing, or renting?

Does the size and nature of your project, branch office, or entire company or agency warrant the installation of a management information system?

Do you have, are you willing to train, or are you prepared to hire personnel to do systems work?

Are you willing to adjust your organization to accommodate an information system?

Are you willing to exercise executive leadership and throw full support behind a systems effort?

Do you want to centralize and tighten your firm's or agency's existing channels of information?

If the answer to any of these questions is "no," think twice before embarking on a program to set up an information system for your company or agency.